Casio FX9000P Cartridge Addressing

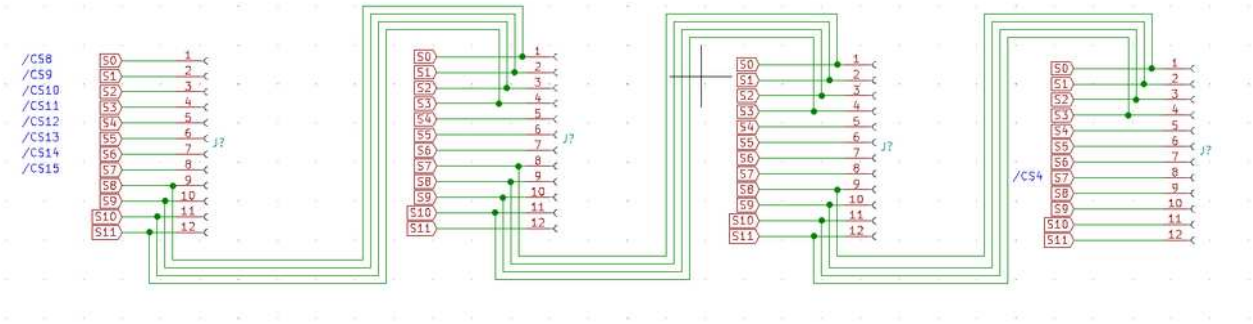
The cartridge PCBs for the FX9000P plug in to four slots. These slots are designed for three types of cartridge:

1) 16K Dynamic RAM
2) 4K RAM
3) 4K ROM

There are rules for the positioning of these cartridges:

Slot 1: 16K RAM
Slot 2: RAM
Slot 3: RAM
Slot 4: ROM RAM

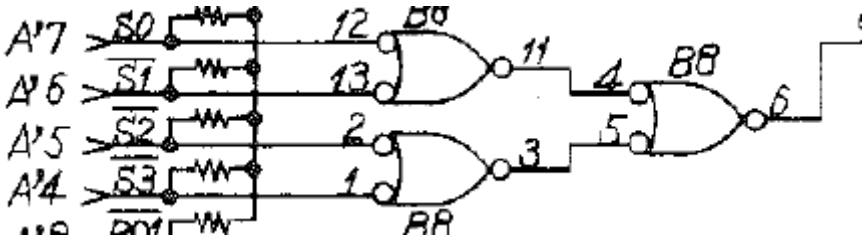
The slots have signals wired up as follows:



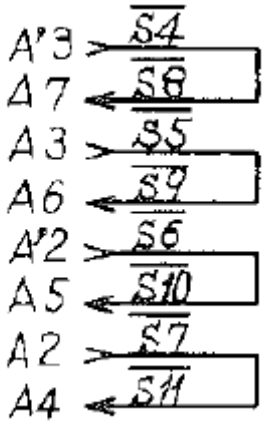
CS8-CS15 are select lines derived from the top 8 4K blocks in the memory map. Each of the cartridges has select lines that it uses to select devices on the card. These select lines are S0 to S3.

16K RAM

The 16K RAM cartridge selects RAM chips using four select lines:



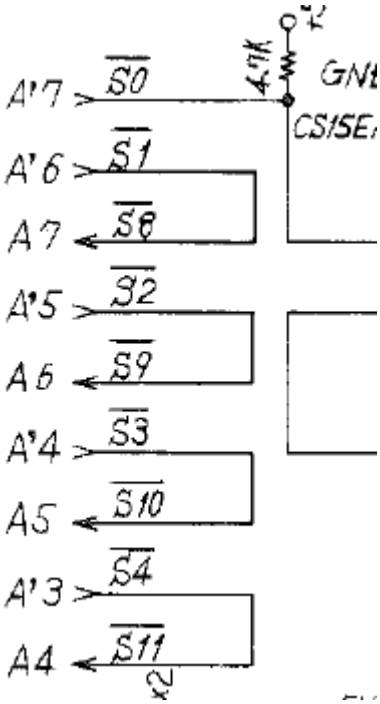
It passes the next select lines to the slot to the right of the one it is plugged in to:



These links connect the select lines after the ones used by the 16K card to the S0..S3 select lines of the next slot. That allows the cartridge in the next slot to use S0..S3 and be positioned in the memory map just after the 16K cartridge.

4K RAM

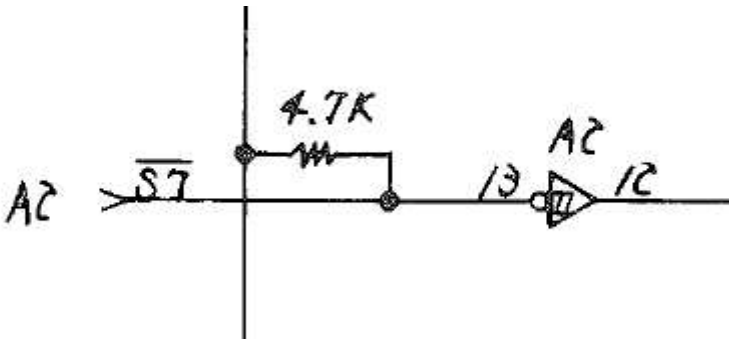
The 4K RAM pack uses just S0 to select its RAM chips, and passes the next select lines on to the slot to the right.



ROM Pack

The ROM pack uses S7 to select the ROMs (and A11 to select one of two ROM chips)

It doesn't pass any Sn select signals on, so cannot be used in any slot to the left of a card.
S7 is only wired up to slot 4, so ROM cartridges cannot be used in any slot other than slot 4.



Cartridge Positioning

Slot 4 is the only slot that a ROM cartridge can be used in due to the wiring mentioned above.
Slots have to be populated from the left to the right as without a cartridge to supply select lines using the links on the PCB, none of S0 .. S3 will be active in a slot with no cartridge to the left.
The 16K cartridge has to be positioned in slot 1, as it uses all four select lines S0 to S3 (it is 16K in size and each select line covers 4K of address space) and so it cannot pass any higher select lines on unless it is in slot 1.
It appears that a 16K cartridge could be in slot 1 and another in slot 2, but then slot 3 would have no select lines for a cartridge. A ROM cartridge could be in slot 4, however.

A 16K cartridge in slot 1, 4K in slot 2, 3 and 4 is a valid configuration.

Address Lines

Unusually, the address lines are inverted when they reach the cartridge slot. The data lines are not inverted. This may be to do with the buffering that the FX9000P has in its circuitry. This inversion has no effect on RAM cartridges as the data will be read in the same way it is written. It does have an effect if a ROM image is being presented by the cartridge. A simple way to deal with this inversion is to invert the address lines in hardware on the cartridge. This requires hardware, of course.